Theme 5: Weather System Observation and Analysis

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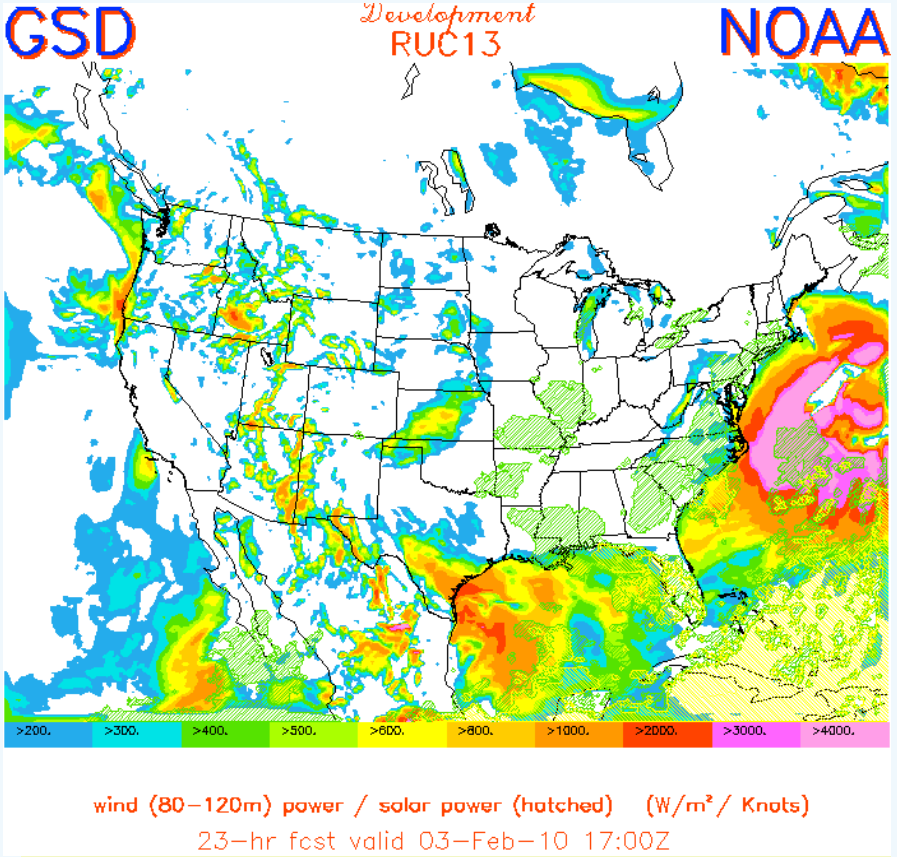
Summary and Way Forward

Why Focus on Observations and Analysis

- Although these are the last themes of the review,
  - **This is where it all starts**
  - We cannot fulfill NOAA's role of *understanding and predicting* our Earth System without *observing* it
  - We need to ensure the observations
    - Are correct
    - Are measuring the most relevant things
  - And, we need to develop the understanding to interpret the observations correctly



Forecast from the Rapid Update Cycle model
- Good outlook for Kansas wind power

Increasingly Diverse Sources of Data

When I got my first job in meteorology

Rawinsonde (12h)

Pibals (6h)

Surface Aviation Obs (hourly)

Wx ships (sfc, rawinsonde)

Ships of opportunity

Radar if you were lucky (analogue PPI, A-scope)

Pireps (Crude, pilot-estimated winds maybe)

Satellite images a curiosity

Now

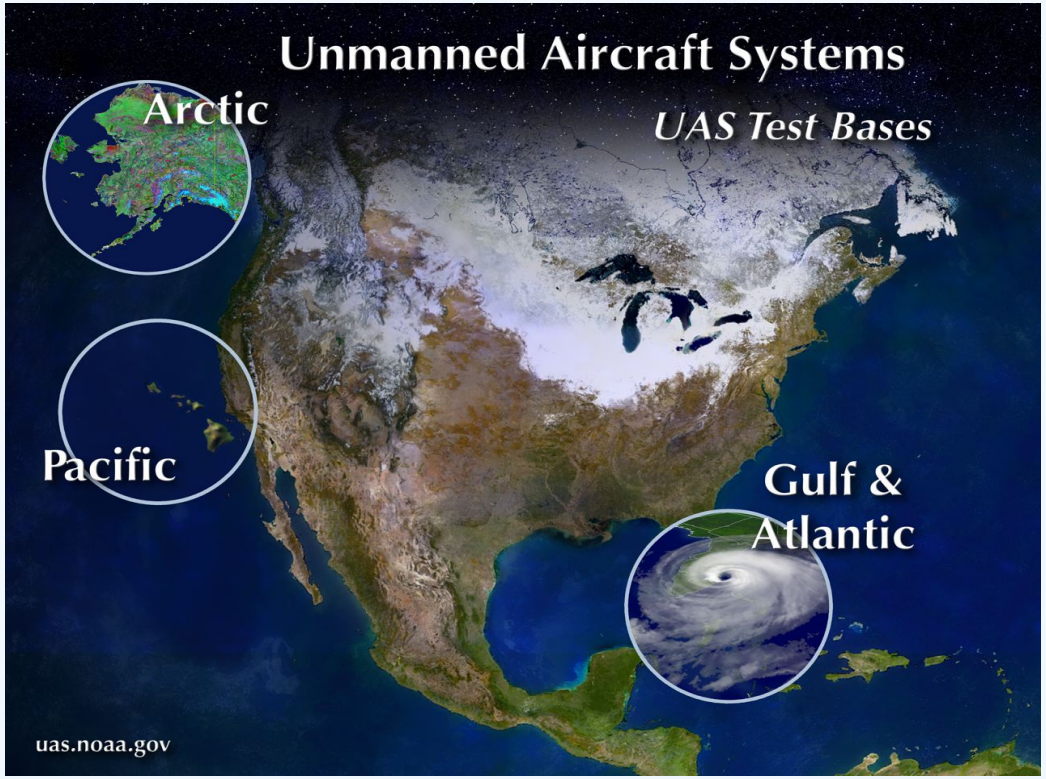
ECMWF assimila-tes ~ 15 types of satellite data!

Hourly obs for Rapid Refresh

Rawinsonde (12h)
NOAA profilers
VAD winds
PBL – prof/RASS
Aircraft (V,temp)
Aircraft (TAMDAR: V,T,RH)
Surface-METAR
Buoy/ships of opportunity
GOES cloud winds
GOES cloud-top pressure
GPS integrated water vapor
Mesonet (temp, dew point)
Mesonet (wind)
METAR-cloud-vis-wx
AMSU-A/B/GOES radiances
Radar reflectivity/ lightning
1km

New data sources noted today
Unmanned aircraft systems (UAS)

- Fill spatial gaps
  - Geographic gaps (e.g., over the ocean)
  - Vertical gaps (between satellites and surface)
- As recognized in NOAA's Technology and Mission Support Goal:



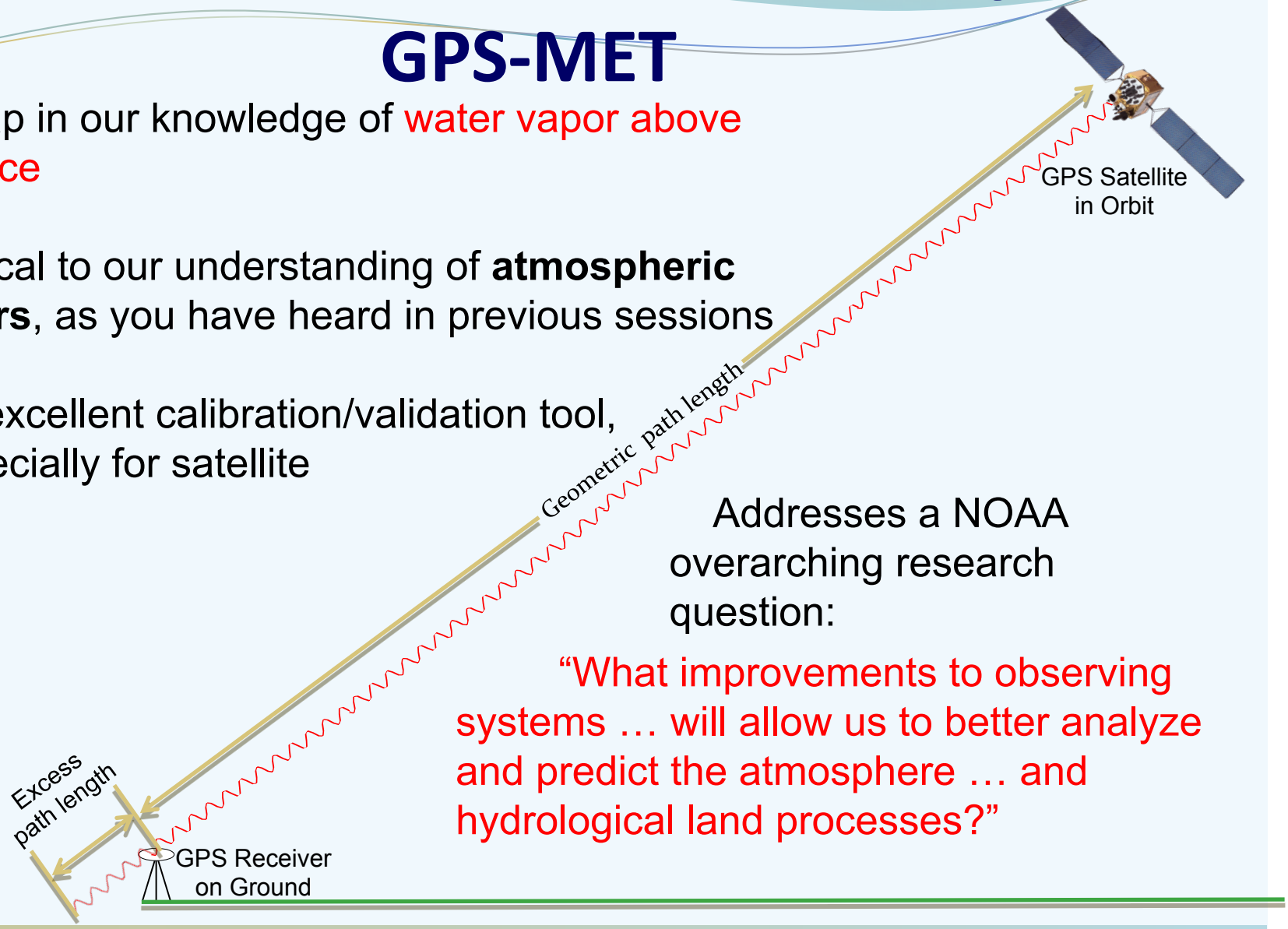
"UAS technology is necessary to sample environments that are either impossible or impractical to observe ..."

New data sources noted today

GPS-MET

Fills a gap in our knowledge of water vapor above the surface

- Critical to our understanding of **atmospheric rivers**, as you have heard in previous sessions
- An excellent calibration/validation tool, especially for satellite data



Addresses a NOAA overarching research question:

"What improvements to observing systems … will allow us to better analyze and predict the atmosphere … and hydrological land processes?"

From an NWP Perspective

Do we need **more** data?

Or do we just need to learn how to more effectively use the data we've got?

In situ data (e.g., aircraft, rawinsonde) easier to use in the assimilation context

but issues of **Coverage** and **Representativeness**

Remotely sensed data (especially satellite)

Good coverage

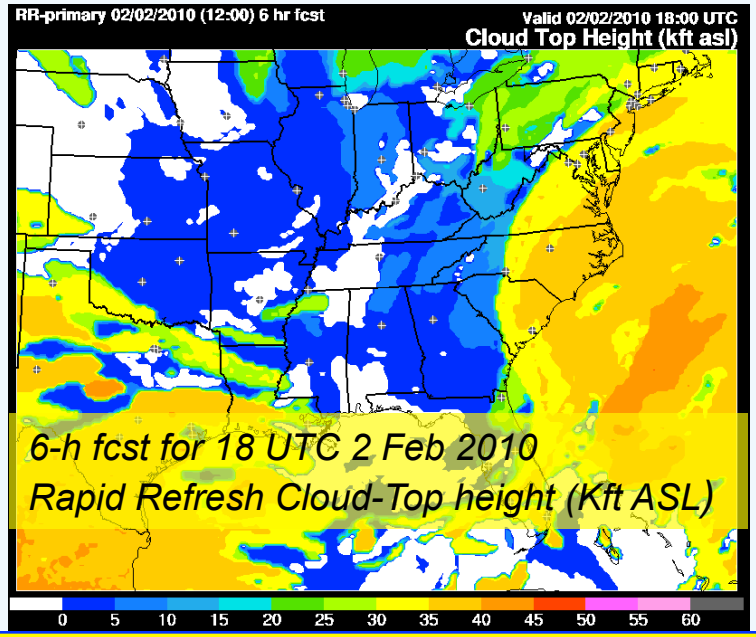
Complicated to use ***but* much progress in last 30 years**

Challenges (opportunities!?)

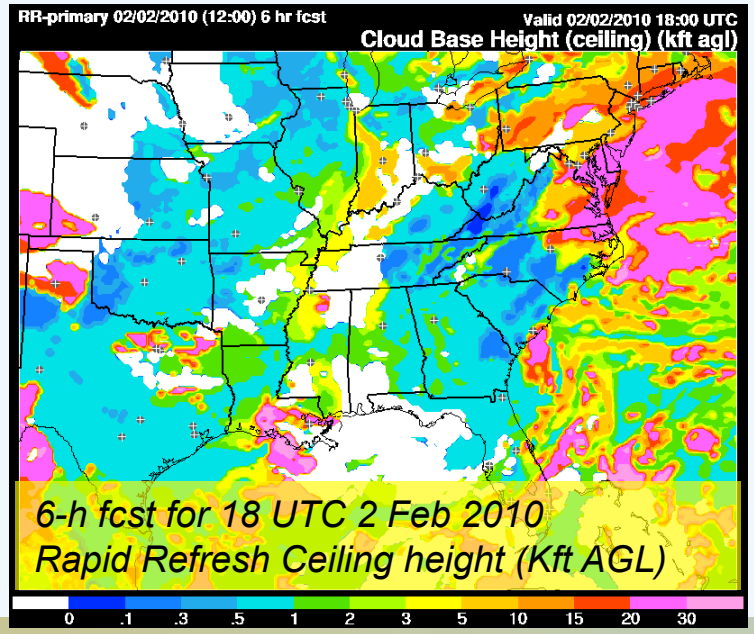
- **Cloudy radiances**
- **Surface emissivity**
- **Bias corrections**

Major NWP Challenge: Water (vapor, liquid, ice)

- Water is the substance of most severe weather
- Both observations of total water and 3-d distribution of each phase needed



6-h fcst for 18 UTC 2 Feb 2010
Rapid Refresh Cloud-Top height (Kft ASL)



6-h fcst for 18 UTC 2 Feb 2010
Rapid Refresh Ceiling height (Kft AGL)

Solution will require
- Complementary observing platforms
- Improved background model forecasts
- Improved analysis techniques

Another NWP Challenge: Data Monitoring and QC

- Sometimes data can systematically degrade forecasts (e.g., poor exposure of observation sites, sensor drift)
- All NWP centers have this challenge
- Strong qc effort a factor in the success of the ECMWF (for example they have often been the first to detect sensor drift on US satellites)

Another NWP Challenge: Data Monitoring and QC (part 2)

- We need to **better identify** troublesome data sources/ platforms and correct or reject them
- Automated QC **should be expanded** [e.g., through tracking obs minus background (short-term forecast) differences]
- **Experienced meteorologists** need to be in the loop to QC the automated QC

ESRL Role in These Challenges

- Continued ESRL/GSD development (in collaboration with NCEP/EMC and NSSL+OU) toward advanced operational **water-vapor/hydrometeor analysis** in Rapid Refresh
  - Satellite
  - GPS wet delay (GPS-MET)
  - Radar (reflectivity, radial velocity, dual-pol parameters)
  - METAR
  - Model background using advanced microphysics
  - Consistency between hydrometeors and mass/momentum
  - Move toward hybrid 4dVAR – EnKF approach

- Continued development of platform-dependent qc monitoring in collaboration with NCEP/EMC

ESRL Role in These Challenges (cont)

- Explore how UAS can be made a **cost-effective** tool for filling gaps in meeting NOAA's mandate for environmental monitoring and prediction

- Investigate potential and actual NWP impacts of adding new or augmenting/decommissioning existing observing systems
  - Observation System Simulation Experiments
  - Observation System Experiments
  - GSD models and modeling/assimilation experience an asset